

Dextrose Prolotherapy and Pain of Chronic TMJ Dysfunction

Many of the subjective symptoms of pain, stiffness, and crunching sensation in patients with TMJ dysfunction were reduced greater than 50% in 92% of the prolotherapy patients in this study.



In the last issue, Dr. Hauser et al reported on a retrospective study on successful dextrose prolotherapy for patients with chronic neck pain. In this study, the authors report on fourteen patients who suffered from TMJ pain for an average of 5.4 years and had seen, on average, four medical doctors—including half who were told that no other treatment options were available. Overall, substantial improvements were reported in range of motion, pain medicine utilization, disability, depression/anxiety, quality of life, and patient satisfaction. These improvements persisted through follow up at eighteen months after the conclusion of prolotherapy treatments. As Dr. Hauser et al report, these positive outcomes resulted despite the inability to individualize treatment protocols since they were done at a charity clinic having limited resources.

—Donna Alderman, DO
Prolotherapy Department Head

By Ross A. Hauser, MD; Marion A. Hauser, MS, RD; and Krista A. Blakemore, BA



Ross A. Hauser, MD



Marion A. Hauser, MS, RD



Krista A. Blakemore, BA

According to the American Dental Association, more than 15% of American adults suffer from chronic facial pain.¹ One of the most common causes is Temporomandibular Joint Disease (TMD), a collective term used to describe a group of medical disorders causing temporomandibular joint (TMJ) pain and dysfunction, and is estimated by The National Institute of Dental and Craniofacial Research of the National Institutes of Health to affect 10.8 million people in the United States at any given time.² It occurs predominantly in women, with the female to male ratio ranging from 2:1 to 6:1, with 90% of those seeking treatment being women in their childbearing years.^{3,4}

The TMJ is often predisposed to similar degenerative changes and pathologies seen in other synovial joints as a consequence of the frequent and repetitive stresses that the TMJ undergoes.⁵ Symptoms commonly associated with TMD include pain at the TMJ, generalized orofacial pain, chronic headaches and ear aches, jaw dysfunction including hyper- and hypo-mobility and limited movement or locking of the jaw, painful clicking or popping sounds with opening or closing of the mouth, and difficulty chewing or speaking.⁶ While pain is the most common symptom, some people report no pain, but still have problems using their jaws. Sometimes the bite just feels “off.” Additional symptoms may include ringing in the ears, ear pain, decreased hearing, dizziness, and vision problems.⁷

The first-line approach to managing TMD typically includes resting the jaw, relaxing the jaw muscles, and doing jaw exercises as recommended by a physical therapist.⁸ Recommendations

may also include eating a soft diet that minimizes hard repetitive chewing of crunchy or chewy foods, such as bagels and steak. All gum chewing must be stopped, talking minimized, and teeth clenching discouraged. Relaxation exercises that emphasize gentle range of motion of the joint are recommended. Application of warm compresses to the affected area twice daily, for 10 minutes, to decrease pain and increase joint movement are done. If this fails, then typically a short course of an anti-inflammatory medication such as ibuprofen is prescribed and often a dental consultation is given. The dentist then evaluates the patient for malocclusion and bruxism. Many times, a mouth splint used at night can completely resolve or control the problem.

When pain, clicking, and locking symptoms persist, TMD sufferers commonly seek out the advice of a myriad of TMJ dental and surgical specialists. Because the causes of TMD are varied and run the gamut from mechanical issues—such as disc degeneration and dislocation or erosion of the fibrocartilagenous surfaces of the condyle, fossa and articular eminence—to hormonal as well as psychological causes,^{9,10,11} the treatment approaches for the chronic TMJ case are also quite varied. As surgery is considered a last resort for TMD, it is common for sufferers to seek out alternatives and one of the treatments they may consider is prolotherapy.

This article presents a retrospective analysis of patients who received dextrose prolotherapy to their temporomandibular joints, and was conducted on a patient population from a charity clinic in rural Illinois. Patients were called by an independent data collector and asked numerous questions concerning their response to the dextrose prolotherapy they received. The data was analyzed in all TMJ pain patients, as well as a subset whose medical doctors told them there were no other treatment options for their TMJ dysfunction and pain.

Prolotherapy Modality

Prolotherapy, as defined by *Webster’s Third New International Dictionary*, is “the rehabilitation of an incompetent structure, such

as a ligament or tendon, by the induced proliferatin of cells.” “Prolo” comes from the world proliferate. Prolotherapy injections proliferate or stimulate the growth of new, normal ligament and tendon tissue.¹² In human studies on prolotherapy, biopsies performed after the completion of treatment showed statistically significant increases in collagen fiber and ligament diameter of up to 60%.¹³

Prolotherapy is based on the concept that the cause of most chronic musculoskeletal pain is ligament and/or tendon weakness (or laxity). Prolotherapy has been shown in one double-blinded animal study over a six-week period to increase ligament mass by 44%, ligament thickness by 27%, and the ligament-bone junction strength by 28%.¹⁴ Another animal study confirmed that prolotherapy induced the normal healing reaction that occurs when an injured tissue is healing itself. In this study, the prolotherapy caused the circumference of tendons to increase by approximately 25% after six weeks time.¹⁵

Prolotherapists have a long history treating TMD since the time of Louis W. Schultz, MD, DDS in the 1930’s. Dr. Schultz was unique in that he was both a dentist and a medical doctor. He was an Associate Professor in the Department of Surgery at the University of Illinois and Rush College of Medicine. He published several papers on the treatment of subluxation of the temporomandibular joint, including one in 1937 in the *Journal of the American Medical Association*.¹⁶ In this paper he described just how common TMJ syndrome was and that the traditional treatments of rest, appliances in the mouth, physical therapy, and surgery were only partially successful. He described a simple method of shortening and strengthening the TMJ capsule by injection (later termed prolotherapy). He tested various solutions in animals until he found one that caused a strengthening of the ligaments that support the TMJ but caused no injury to other structures.¹⁷ In regard to prolotherapy into the TMJ he found that:

- There was no alteration of the normal joint cavity; the proliferation occurred in the ligaments.
- There were no gross changes in the ligaments other than their thickening.
- Lymphocytes infiltrate the area injected within 30 minutes.
- Proliferation of tissue can be seen in four to six days.

He found that a series of three to five injections were required to often permanently stop the clicking, pain, and hypermobility of the TMJ joint. Dr. Schultz noted that over the course of his twenty years of doing prolotherapy for TMD, not only was it effective, but the treatment lacked significant side effects.

Dr. Schultz taught the technique of TMJ prolotherapy to Gustav S. Hemwall, MD. The primary author has worked with Dr. Hemwall and eventually assumed his practice upon his retirement from medicine in 1996. After acquiring Dr. Hemwall’s practice, Dr. Schultz’s son came to the clinic for a prolotherapy evaluation. He commented that in his father’s many years of practice as a dentist, medical doctor, and surgeon, the procedure that gave him the most amount of satisfaction in treating a TMJ case was prolotherapy.

While practitioners of prolotherapy since the time of Dr. Schultz have commonly used prolotherapy for all sorts of TMD, even in cases not involving subluxation, no other studies have been done since that time. This retrospective observational study was undertaken to evaluate the effectiveness of Hemwall-Hackett dextrose prolotherapy—not just for TMJ pain—but also for quality of life measures.

Patients and Methods

Framework and Setting. In October 1994, the authors started a Christian charity medical clinic called Beulah Land Natural Medicine Clinic in an impoverished area in southern Illinois. The primary modality of treatment offered was Hemwall-Hackett dextrose prolotherapy for pain control. Dextrose was selected as the main ingredient in the solution because it is the most common proliferant used in prolotherapy, is readily available,

is inexpensive when compared to other proliferants, and has a high safety profile. The clinic met every three months until it ended in July 2005. All treatments were given free of charge.

Patient Criteria. General inclusion criteria included being at least 18 years old, having TMD for more than six months, and a willingness to undergo at least four prolotherapy sessions (unless the pain remitted with fewer sessions).

Interventions. Each patient received four to six injections of a 15% dextrose, 0.2% lidocaine solution with a total of two to four cc’s of solution used per temporomandibular joint. Typically, one cc of solution was injected into the joint and the remaining solution was injected onto the TMJ ligament and capsular attachments on the zygomatic arch and mandibular condyle and neck (See Figures 1 and 2). The patients were asked to hold their mouths half open while the injections were given. No other therapies were used. The patients were asked to reduce or stop other pain medications and therapies they were using as much as the pain would allow.

Data Collection. Patients who were seen in the clinic in the years from 2001-2005 and met the inclusion criteria were called by telephone and interviewed by an independent data collector who had no prior knowledge of prolotherapy and was the sole data collector gathering the patient information during the telephone interviews. The patients were asked a series of detailed questions about their pain and previous treatments before starting prolotherapy. Their response to prolotherapy treatments was also documented in detail with an emphasis on the effect the treatments had on their need for subsequent pain treatments, as well as their quality of life. Specifically, patients were asked questions concerning years of pain, pain intensity, overall disability, number of physicians seen, medications taken, stiffness, crunching sensations in the joint, quality of life concerns, and psychological factors. Also noted was whether the post-treatment benefits continued substantially after the sessions concluded.

Statistical Analysis. For the analysis, the results of the patient responses were calculated by another independent data collector who had no prior knowledge of prolotherapy. Pre-prolotherapy treatment responses were compared with the patients’ responses to the same questions after prolotherapy treatment.

TABLE 1. PATIENT CHARACTERISTICS PRIOR TO PROLOTHERAPY

TMJ patients	14
Number of Male Patients	3
Number of Female Patients	11
Average age of TMJ patients	50
Average number of MDs seen (Q3)	4
Average years of pain (Q2)	5.4
Surgery only option to chronic pain	14%
No other treatment options available	50%
Taking 1 pharmaceutical drug for pain	31%
Taking 2 or more pharm drugs for pain	39%

Patient Characteristics. Complete data was obtained on 14 patients who met the inclusion criteria. Of the 14 study participants, 63% were female and 37% were male. The average age was 50. Patients reported an average of 5.4 years in pain. Fifty-one percent had pain greater than six years. The average patient saw four medical doctors before receiving prolotherapy. Fifty percent of the patients were told by their physicians that no other treatment options existed for their pain problem and 14% were told that surgery was their only option. Thirty-one percent were taking one pharmaceutical drug, while 39% were taking two or more drugs for pain (See Table 1).



FIGURE 1. Typical injection sites for Hemwall-Hackett dextrose prolotherapy of the TMJ.

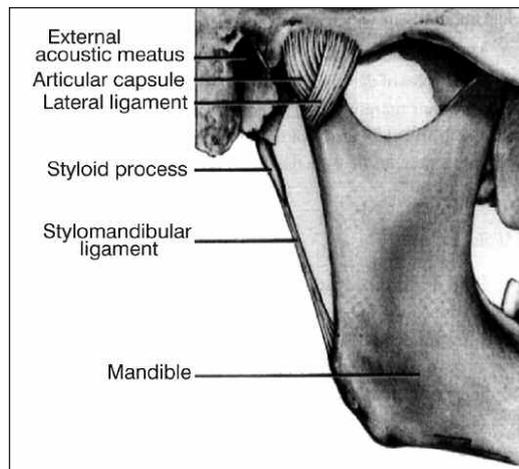


FIGURE 2. Ligamentous structures of the TMJ typically treated with Hemwall-Hackett dextrose prolotherapy.

Treatment Outcomes

Patients received an average of 4.6 prolotherapy treatments. The average time of follow-up from their last prolotherapy session was eighteen months.

Pain, Crunching Sensation, and Stiffness. Patients were asked to rate their pain and stiffness on a scale of 1 to 10, with 1 being no pain/stiffness and 10 being severe, crippling pain/stiffness. The 14 patients had an average starting pain level of 5.9, crunching sensation in the TMJ of 5.5, and stiffness of 5.4. Their average ending pain, crunching, and stiffness levels were 2.5, 2.7, and 2.4 respectively (See Figure 3). Over 71% percent said that they had retained at least 75% of the improvements and 91% noted that they retained at least 50% of their improvements in their pain, crunching, and stiffness levels since the last treatment session. Ninety-three percent of patients reported that pain relief was at least 50% while 57% reported greater than 75% pain relief. Only one person noted that the long term pain relief was only somewhat successful in having only 25-49% of the pain relieved.

Range of Motion. Patients were asked to rate their range of motion on a scale of 1 to 7, with 1 being no motion, 2 through 5 were fractions of normal motion, 6 was normal motion, and 7 was excessive motion. The average starting range of motion was 4.3 and ending range of motion was 5.1. Before prolotherapy, 29% had very limited motion (49% or less of normal motion). This decreased to only 7% after treatments were concluded.

Pain Medication Utilization. Seventy-one percent discontinued pain medications altogether after prolotherapy. In all, 90% of patients on medications at the start of prolotherapy were able to decrease them by 75% or more. None of the patients had to increase pain medication usage after stopping prolotherapy. Fifty-seven percent of patients needed no additional pain management care after prolotherapy. After prolotherapy, 93% of patients were able to decrease additional pain management care by 50% or more.

Disability. In regard to quality of life issues prior to receiving treatment, 50% exhibited overall disability of at least 50% in that they could only do about half of the jaw motions without pain. This decreased to 7% after prolotherapy. In regard to overall TMJ disability, only 14% noted almost no disability (25% or less) prior to prolotherapy, but this increased to 72% after treatment

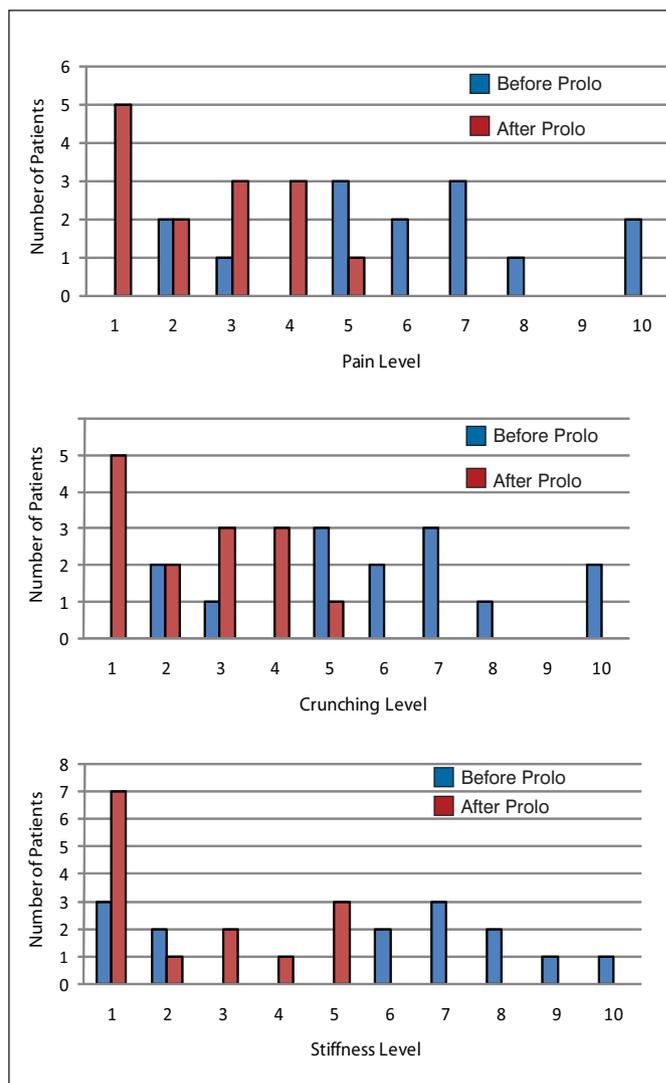


FIGURE 3. Starting and ending pain, crunching, and stiffness levels before and after receiving Hemwall-Hackett dextrose prolotherapy in 14 patients with unresolved TMJ pain.

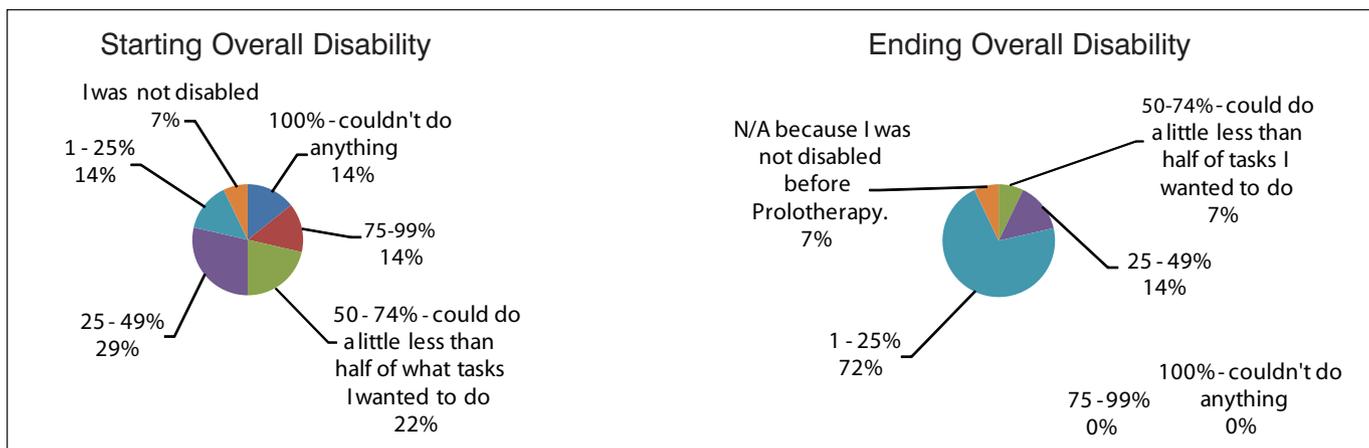


FIGURE 4. Starting and ending overall disability before and after receiving Hemwall-Hackett dextrose prolotherapy in 14 patients with unresolved TMJ pain.

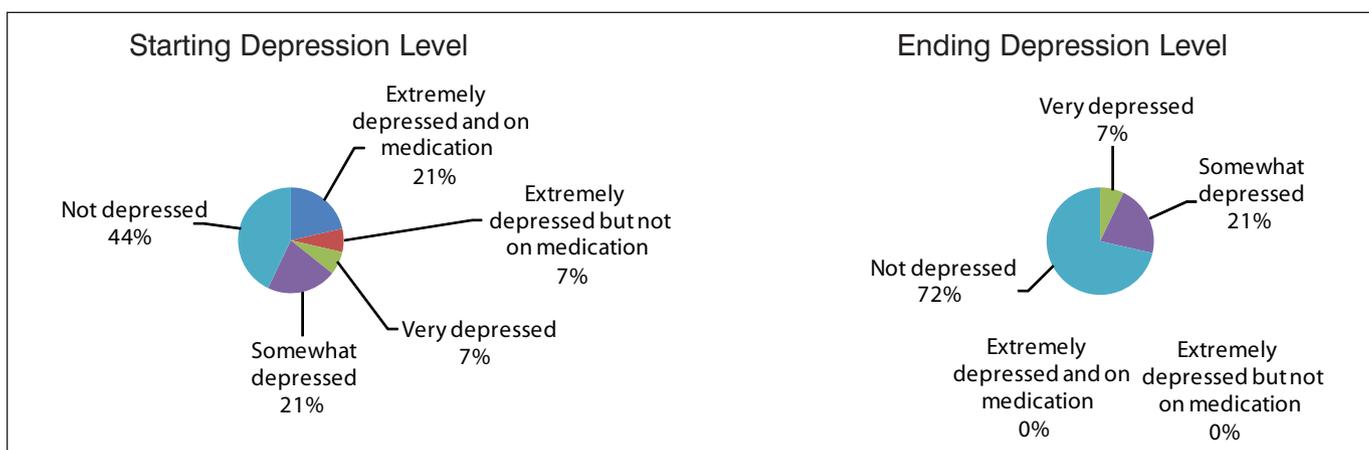


FIGURE 5. Starting and ending depression level before and after receiving Hemwall-Hackett dextrose prolotherapy in 14 patients with unresolved TMJ pain.



FIGURE 6. Starting and ending anxiety level before and after receiving Hemwall-Hackett dextrose prolotherapy in 14 patients with unresolved TMJ pain.

(See Figure 4).

Depression & Anxiety. Prior to prolotherapy, 56% of patients reported feelings of depression and 64% reported feelings of anxiety. After treatments, only 28% reported depressed feelings and 36% re-

ported feelings of anxiety (See Figures 5 and 6). Patients reported that on average 86% of the improvements in depression and anxiety have at least somewhat continued. Seventy-eight percent of these patients reported 75% continuing improve-

ment at the time of follow-up.

Sleep. Sixty-four percent of patients reported their pain interrupted their sleep prior to prolotherapy treatments and 55% of them subsequently showing improvements in their sleeping ability after treatments.

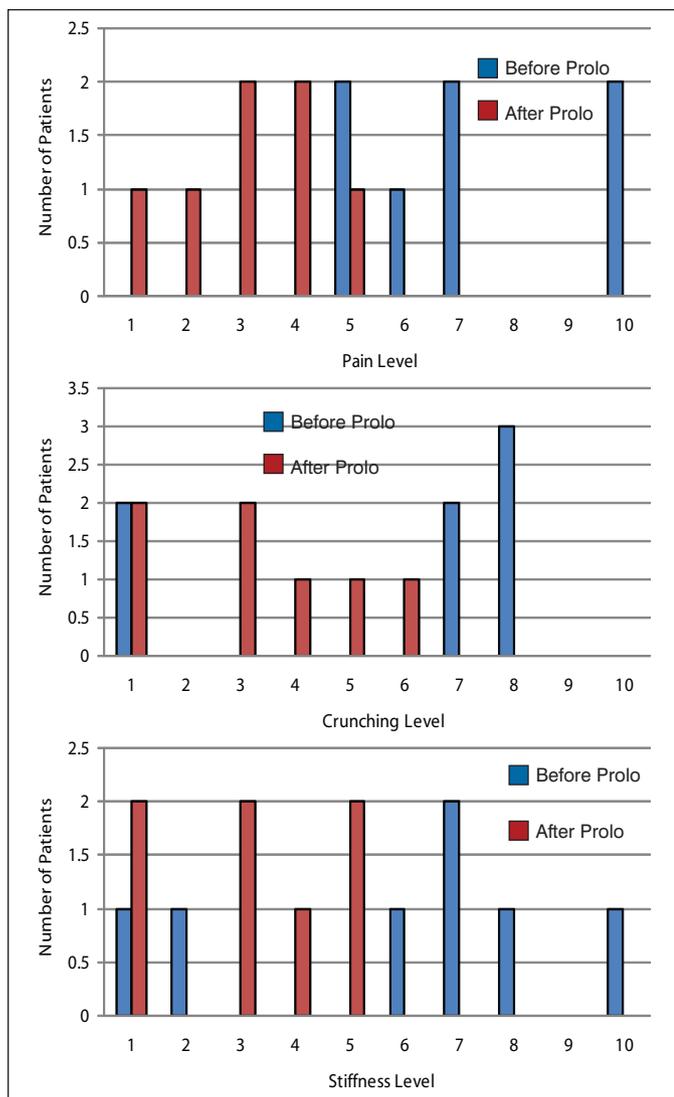


FIGURE 7. Starting and ending pain, crunching, and stiffness levels before and after receiving Hemwall-Hackett dextrose prolotherapy in 7 patients with unresolved TMJ pain who were told that there were no other treatment options.

Quality of Life. To a simple yes or no question, “Has prolotherapy changed your life for the better?” 100% of patients treated answered “yes.” In quantifying the response,

- Eighty-six percent felt their life was at least very much better from prolotherapy
- Sixty-nine percent stated that the results from prolotherapy have very much continued to this day (75% or greater).
- One hundred percent felt that they still have some benefits (at least 25%) from the prolotherapy they received.

Patients who experienced regression of some of their symptoms were asked, “Are there reasons beside the prolotherapy effect wearing off that are causing some return of your pain/disability?” 79% answered “yes.” The patients noted the reasons for some of their returning pain were the following:

- stopped prolotherapy treatments too soon, (before pain was completely gone):37%
- re-injury: 14%

- increased life stressors: 21%
- new area of pain: 7%

Of the patients whose pain recurred after prolotherapy was stopped, 58% were planning on receiving additional prolotherapy treatments.

Patient Satisfaction. Eighty-six percent of patients knew someone who had benefited from prolotherapy. In fact, 44% came to receive their first prolotherapy session at the recommendation of a friend who had already received prolotherapy. Ninety-three percent of patients treated considered the prolotherapy treatment to be very successful (greater than 50% pain relief). Fifty-seven percent noted the prolotherapy was very successful (greater than 75% pain relief). None indicated that the prolotherapy treatment made them worse. One hundred percent had subsequently recommended prolotherapy to someone.

“No Other Treatment Options” Subgroup Analysis. Fifty percent (n=7) of the patients had been told by their doctors that there were no other treatment options for their pain prior to presenting for prolotherapy. This group had average starting pain, stiffness, and crunching levels of 7.1, 5.9, and 5.7, respectively, before prolotherapy. Their ending levels were 3.1, 3.1 and 3.3 for pain, stiffness and crunching levels after treatment (See Figure 7). Three of the patients noted less than 25% normal TMJ motion before prolotherapy, but after prolotherapy every patient said they had improved to greater than 25% of normal motion. Before prolotherapy all seven patients were taking at least one pain medication while, after treatment, only two were taking medications. Five of the patients (71%) had 75% or greater pain relief, with the other two patients achieving 50-74% pain relief. Before prolotherapy, 100% had depressed feelings, with three of the seven (43%) being on medications. All three on medications were able to get off medications after prolotherapy and four of the seven (57%) no longer had depressed feelings (See Figure 8). In this group of seven patients, six felt they still had at least 75% of the benefit they received after the prolotherapy treatments stopped.

Principal Findings. The results of this retrospective, uncontrolled, observational study, demonstrated that prolotherapy helps decrease pain and improve the quality of life of patients with chronic temporomandibular joint symptoms. Decreases in pain, stiffness, and crunching levels of the TMJ were seen, even in patients who were told by their physicians that no other treatment options were available. Fifty-seven percent of the patients achieved greater than 75% pain relief with prolotherapy and 93% of patients stated prolotherapy relieved them of at least 50% of their pain. In regard to quality of life issues prior to receiving treatment, 50% had an overall disability of at least 50% (jaw motions restricted by about half). This decreased to 7% after prolotherapy. Prolotherapy also caused clinically relevant improvements in patients’ TMJ range of motion, sleep, depressive and anxious feelings. Ninety percent of patients on medications at the start of prolotherapy were able to decrease them by 75% or more. One hundred percent of patients said that dextrose prolotherapy changed their life for the better. Eighteen months, on average, after their last prolotherapy treatment, one hundred percent of patients said they had retained the majority of their benefits from the treatment.

Study Strengths and Weaknesses. Our study does not compare to clinical trial in which an intervention is investigated under controlled conditions. Instead, its aim was to document

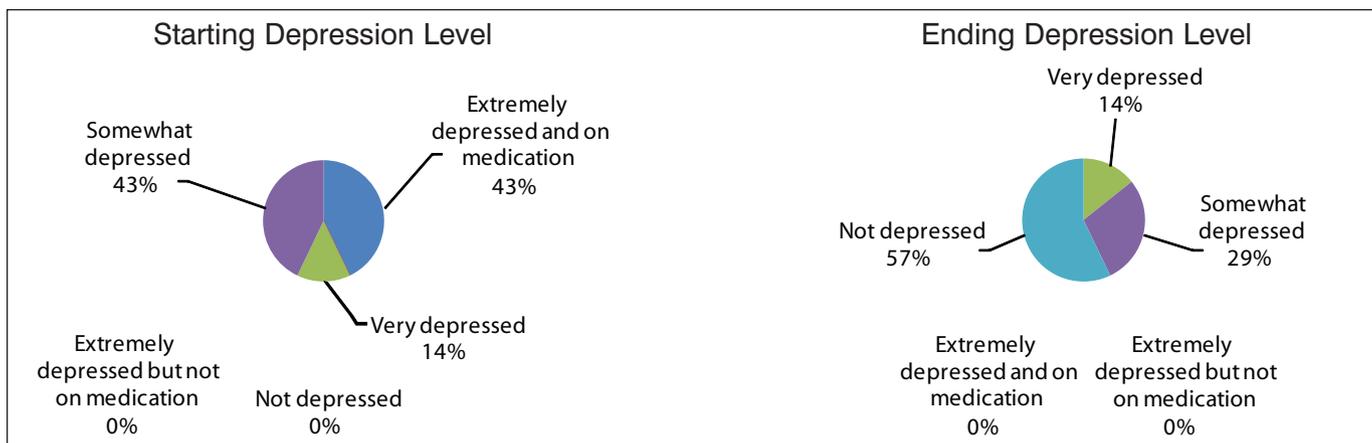


FIGURE 8. Starting and ending depression levels before and after receiving Hemwall-Hackett dextrose prolotherapy in 7 patients with unresolved TMJ pain who were told that there were no other treatment options.

the response of patients with chronic temporomandibular joint dysfunction to the Hemwall-Hackett technique of dextrose prolotherapy. Strengths of the study were that numerous quality of life parameters affecting TMJ sufferers were studied. Quality of life issues such as stiffness, range of motion, overall disability, sleep, anxiety, and depression—in addition to pain level—are important factors affecting an individual with chronic TMJ syndrome. Decreases in medication usage and additional pain management care were objective measures that were also documented.

Though the sample in this study was small (n=14), the quality of the cases treated is notable. The average person in this study had unresolved TMJ pain/dysfunction for 5.4 years and had been seen, on average, by four medical doctors prior to receiving prolotherapy. Fifty percent of the cases were told that no other treatment options existed and 14% were told surgery was their only option. A follow-up time of eighteen months, on average, since their last treatment session provided a measure of the long-lasting effect of this modality.

Because this was a charity medical clinic with limited resources and personnel, the only therapy offered was prolotherapy treatments given every three months. In private practice, the Hemwall-Hackett technique of dextrose prolotherapy is typically given every four to six weeks. If a client is not improving or has poor healing ability, the prolotherapy solutions may be changed or strengthened or the client is advised about additional measures to improve their overall health. This can include advice on diet, supplements, exer-

cise, changes in medications, additional blood tests, physiotherapy, and/or other medical care. Often clients are weaned immediately off any anti-inflammatory and narcotic medications that inhibit the inflammatory response that is needed to achieve a healing effect from prolotherapy. Since none of these were done, the results of this study are expected to represent the least optimum level of success achievable with Hemwall-Hackett dextrose prolotherapy.

Another shortcoming of this study was the subjective nature of some of the evaluated parameters, including pain, anxiety, depression, and disability levels since the results relied on answers to questions by the patients. Further, any additional pain management care that the patients may have been receiving was not controlled. Lack of x-ray and MRI correlation for diagnosis and response to treatment, as well as a lack of physical examination documentation in the patients' charts made categorization of the patients into various diagnostic parameters impossible.

Discussion. While the exact cause of chronic temporomandibular dysfunction is still debated, this study did demonstrate that the Hemwall-Hackett technique of dextrose prolotherapy improves not only the pain level for those having chronic TMD, but also a host of other quality of life measures. The Hemwall-Hackett technique of dextrose prolotherapy to the temporomandibular joint involves injections into the joint, as well as the fibro-osseous junction of the ligament and capsular attachments on the zygomatic arch, as well as the mandibular neck and condyle. Clearly the structural goal of Hemwall-

Hackett dextrose prolotherapy is to improve the stability of the TMJ by enhancing capsular and ligament strength. Congenital disorders that are characterized by overstretched ligaments, such as Ehlers-Danlos Syndrome, are typically predisposed to TMJ problems.¹⁸ Weakening of the TMJ capsule and ligament would explain a lot of the varied pathology involving TMD including joint subluxations, disc displacements, as well as muscle spasms and myofascial pain patterns.

The most common cause of TMJ pain is myofascial pain dysfunction syndrome and primarily involves the muscles of mastication.¹⁹ While massage, physiotherapy, pain medications, splints, surgeries, and other treatment modalities offer temporary help, they rarely cure the condition.^{20,21,22} A known cause of persistent muscle spasms and myofascial pain dysfunction is underlying ligament laxity.²³ By stimulating ligament and capsular repair for such cases, prolotherapy would represent a more permanent solution.

The most common presentation of the TMJ is disc displacement.²⁴ In essence, this is when the articular disc, attached anteriorly to the superior head of the lateral pterygoid muscle and posteriorly to the retrodiscal tissue, moves out from between the condyle and the fossa, so that the mandible and temporal bone contact something other than the articular disc. In most instances of the disorder, the disc is displaced anteriorly upon translation. On opening, a "pop" or "click" can sometimes be heard—and usually felt—indicating the condyle is moving back onto the disc.²⁵

The TMJ is divided into an upper and lower joint cavity by a fibrocartilaginous

articulating disc.²⁶ It is thicker posteriorly, thus making posterior dislocations more unlikely. Anteriorly, the disc is fused with the thin, loose, and fibrous joint capsule. The ligaments which contribute to the formation of the fibrous joint capsule and unite the articular bones are the temporomandibular (a.k.a. lateral), sphenomandibular, and stylomandibular. The temporomandibular ligament restrains the movement of the mandible and prevents compression of tissues behind the condyle.²⁷ Some authors note that this collateral ligament is simply a thickening of the joint capsule.²⁸ The joint capsule itself attaches to the articular eminence, the articular disc, and the neck of the mandibular condyle. Basically, the articular disc is a fibrous extension of the capsule between the two bones of the joint.²⁹ The sphenomandibular and stylomandibular ligaments keep the condyle, disc, and temporal bone firmly opposed and the multiple ligamentous attachments provide disc stability. Laterally, the disc is continuous with ligament tissue attaching it to the neck of the condyle.³⁰ While the cause of disc displacement is still under debate, an argument could be made that for many, it is injury to the joint capsule and TMJ ligament complex that is the issue. Anteriorly, the TMJ disc depends on the support of the joint capsule and TMJ ligament complex. If, for some reason, these became weakened, stretched, or torn, anterior disc dislocation would result. Only treatments designed to specifically strengthen and repair the injured joint capsule and ligament structures—such as prolotherapy—would have a lasting effect.

Conclusions

In this observational study, the Hemwall-Hackett technique of dextrose prolotherapy used on patients who presented with over five years of unresolved TMJ pain and dysfunction were shown to improve their quality of life even eighteen months subsequent to their last prolotherapy session. All patients reported significantly reduced levels of pain, stiffness, crunching sensation, disability, depression, anxiety, medication, and other pain therapy. They also reported improved range of motion and sleep. The results confirm that prolotherapy is a treatment that should be highly considered for people suffering with unresolved temporomandibular joint pain and dysfunction. ■

Ross A. Hauser, MD is the Medical Director of Caring Medical and Rehabilitation Services in Oak Park, IL and is a renowned prolotherapist and Natural Medicine Specialist with a national referral base seeing patients from all over the USA, and abroad. Dr. Hauser and his wife, Marion, authored the national best seller “Prolo Your Pain Away! Curing Chronic Pain with Prolotherapy,” now in its third edition, along with a four-book topical mini series of prolotherapy books. He also spearheaded the writing of a 900-page epic sports book that discusses the use of prolotherapy for sports injuries, “Prolo Your Sports Injuries Away! Curing Sports Injuries and Enhancing Athletic Performance with Prolotherapy.”

Marion A. Hauser, MS, RD is the CEO of Caring Medical and Rehabilitation Services, a comprehensive Natural Medicine Clinic in Oak Park, IL and owner of Beulah Land Nutritionals. As a registered dietitian, Marion is also a well-known speaker and writer on a variety of topics related to natural medicine and nutrition providing information for weekly e-newsletters and TV shows on a variety of health topics. Marion has recently released “The Hauser Diet: A Fresh Look at Healthy Living.” Along with her husband, Dr. Ross Hauser, Marion co-authored the national best seller entitled “Prolo Your Pain Away! Curing Chronic Pain with Prolotherapy” along with a four-book topical mini series of prolotherapy books, as well as a comprehensive sports book discussing the use of prolotherapy for sports injuries.

Krista A. Blakemore, BA graduated with honors from Eastern Washington University in Cheney, Washington in 2002, and is research assistant to Ross and Marion Hauser of Caring Medical and Rehabilitation Services in Oak Park, Illinois.

References

1. American Dental Association. Available at http://www.ada.org/public/topics/tmj_tmj.asp Accessed 11/9/07.
2. National Institute of Dental and Craniofacial Research. Available at: <http://www.nidcr.nih.gov>. Accessed 11/9/07.
3. Van Korff M, Dworkin, SF, Le Resche L, and Kruger A. An epidemiologic comparison of pain complaints. *Pain*. 1988. 32: 173-183.
4. Ta LE and Dionne RA. Treatment of painful temporomandibular joints with a cyclooxygenase-2 inhibitor: a randomized comparison of celecoxib to naprosyn. *Pain*. 2004. 111: 13-21.
5. Helland MM. Anatomy and function of the temporomandibular joint. *JOSPT*. 1980. 1(3): 145-52.
6. Mayo Clinic. Available at: <http://www.mayoclinic.com/health/tmj-disorders/DS00355/DSECTION=6> Accessed 11/9/07.
7. The TMJ Association. Available at: <http://www.tmj.org/basics.asp> Accessed 11/9/07.
8. Eriksson PO and Zafar H. Musculoskeletal disorders in the jaw, face and neck. In Rakel RE, Bope ET, eds., *Conn's Current Therapy in TMJ*. WB Saunders. Philadelphia, PA. 2005. pp 1128-1133.
9. Malone TP, McPoi T, and Nitz AJ. *Orthopaedic and Sports Physiotherapy. Third Edition*. Mosby, Philadelphia, PA. 1997.
10. Tabassum N, Trang D, and Gihan H. Relaxin's Induction of Metalloproteinases is Associated with the Loss of Collagen and Glycosaminoglycans in Synovial Joint Fibrocartilaginous Explants. *Arthritis Res Ther*. 2005. 7(1): R1-R11.
11. Meldolesi G and Picardi A. Personality and psychopathology in patients with temporomandibular joint dysfunction syndrome. A controlled investigation. *Psychother Psychosom*. 2000. 69: 322-328.
12. Dorman T. Treatment for spinal pain arising in ligaments using Prolotherapy: A retrospective study. *Journal of Orthopaedic Medicine*. 1991. 13(1): 13-19.
13. Klein R. Proliferant injections for low back pain: histologic changes of injected ligaments and objective measures of lumbar spine mobility before and after treatment. *Journal of Neurology, Orthopedic Medicine and Surgery*. 1989. 10: 141-144.
14. Liu Y. An in situ study of the influence of a sclerosing solution in rabbit medical collateral ligaments and its junction strength. *Connective Tissue Research*. 1983. 2: 95-102.
15. Maynard J. Morphological and biomechanical effects of sodium morrhuate on tendons. *Journal of Orthopaedic Research*. 1985. 3: 236-248.
16. Schultz L. A treatment of subluxation of the temporomandibular joint. *JAMA*. September 25, 1937.
17. Schultz L. Twenty years' experience in treating hypermobility of the temporomandibular joints. *American Journal of Surgery*. Vol. 92. December 1956.
18. Hagberg C, Korpe L, and Berglund B. Temporomandibular joint problems and self-registration of mandibular opening capacity among adults with Ehlers-Danlos Syndrome. A questionnaire study. *Ortodontia Res*. 2004. 7(1): 40-6.
19. Darnell M. A proposed chronology of events for forward head posture. *The Journal of Craniomandibular Practice*. 1983. 1: 62-66.
20. Ernest E. Three disorders that frequently cause temporomandibular joint pain: internal derangement, temporal tendonitis, and Ernest syndrome. *Journal of Neurological Orthopedic Surgery*. 1986. 7: 189-191.
21. *Headache Relief Newsletter, Edition 13*. Philadelphia, PA: The Pain Center, 1995.
22. Al-Ani MZ, et al. Stabilisation splint therapy for temporomandibular pain dysfunction syndrome. *Cochrane Rev Abstract*. 2007. Available at: http://www.medscape.com/viewarticle/486213_print Accessed 11/9/07.
23. Hauser R and Hauser M. *Prolo Your Sports Injuries Away!* Beulah Land Press. Oak Park, IL. 2001.
24. Epker, J. A model for predicting TMD: Practical application in clinical settings. *Journal of the American Dental Association*. 1999. 130: 1470-1475.
25. Tecco S, Festa F, and Salini V. Treatment of joint pain and joint noises associated with a recent TMJ internal derangement: a comparison of an anterior repositioning splint, a full-arch maxillary stabilization splint, and an untreated control group. *Cranio*. 2004. 22(3): 209-219.
26. Rao V, Ferule A, and Karasick D. Temporomandibular joint dysfunction: Correlation of MR imaging, arthrography and arthroscopy. *Radiology*. 1990. 174: 663-667.
27. Hall L. Physiotherapy treatment results for 178 patients with temporomandibular joint syndrome. *Am J Otol*. Jan 1984. 5(3): 183-96.
28. Laskin D. Diagnosis of pathology of the temporomandibular joint: Clinical and imaging perspectives. *Radiol Clin North Am*. 1993. 31: 135-147.
29. Temporomandibular Joint. Available at http://en.wikipedia.org/wiki/Temporomandibular_joint Accessed 11/9/07.
30. Roth C, Ward R, and Tsai S. MR Imaging of the TMJ: A Pictorial Essay. *Appl Radiol*. 2005. 34(5): 9-16.